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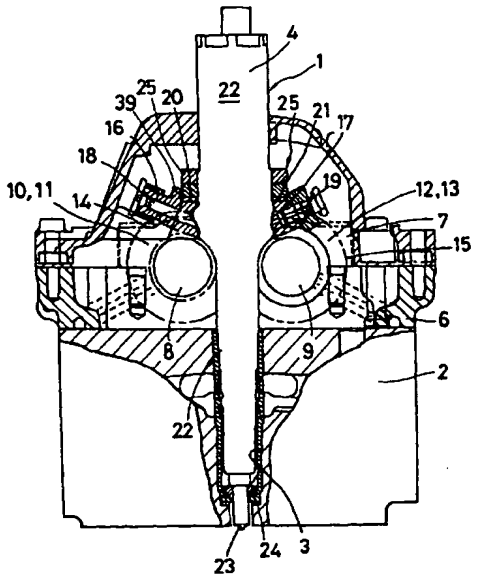
(54) Injectors fixing structure for engines

(57) In this injector fixing structure for engines, injectors 1 provided with fuel supply bosses 16 and fuel return bosses 17 are disposed between two cams 10, 11 or 12, 13 mounted on valve driving cam shafts 8, 9, and are fixed to a cylinder head 2 by clamp members 25. The fuel supply bosses and fuel return bosses have clamping pressure receiving surface portions 20, 21, and the injectors are fixed to the cylinder head by pressing these clamping pressure receiving surface portions by the clamp members. Accordingly, the portions of the injectors clamped are lower, and the height of the injectors as a whole decreases, so that the fixing of the clamp members to the cylinder head is done easily, whereby the injector fixing structure is formed compactly. The injectors are provided with turning stopping portions 39, 40 adapted to be engaged with the clamp members.

FIG. 1



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Description

This invention relates to an injector fixing structure for engines which is used to fix an injector to a cylinder in, for example, a direct injection type engine.

The conventional injector fixing structures for fixing an injector for an engine to a cylinder include the injector fixing structures disclosed in, for example, Japanese Utility Model Laid-Open Nos. 17171/ 1991 and 69359/1994. In these injector fixing structures, the injectors are fixed to a cylinder head by their respective clamp members.

As shown in Figs. 8 and 9, the clamp member is used to fix an injector 51 to a cylinder head 52 by laying a clamp body 55 like a beam between an injector 51 and the cylinder head 52, and tightening an intermediate portion of the clamp body 55 by a clamp bolt 53 and a nut 54. A rear end portion of the clamp body 55 is set in contact with the cylinder head 52, and a bifurcated part 56 at a front end portion of the clamp body is brought into contact with a pair of stepped clamping pressure receiving surfaces 57 formed on the side portions of the injector 51, whereby the clamp body 55 is positioned with respect to the cylinder head 52. The injector 51 can be fixed in a mounting hole 58 of the cylinder head 52 via the bifurcated part 56 by tightening the clamp bolt 53 which is inserted through the intermediate portion of the clamp body 55 onto the cylinder head 52, or tightening the nut 54 screwed on the clamp bolt 53. A gas sealing packing 59 provided in the mounting hole 58 is capable of preventing a gas leak between a combustion chamber and the mounting hole 58.

There is the possibility that the vibration occurring during an operation of an engine causes the clamp member to be turned around the clamp bolt 53, or the injector 51 to be turned around the axis thereof, so that the contact portions of the bifurcated part 56 and clamping pressure receiving surfaces 57 of the injector 51 are displaced. When these contact portions are displaced, a sealing load is not uniformly imparted to the packing 59 provided at an inserted end in the cylinder head 52 of the injector 51, and a gas leak from the sealed portion occurs. An injecter fixing structure formed so as to prevent a gas leak from a sealed portion has been proposed (refer to, for example, Japanese Utility Model Laid-Open No. 69359/1994) in which a pin type projection provided at a rear end portion of a clamp body is brought into contact with a side surface of a cylindrical portion of a cup-shaped plug set in a hole-as-cast of a cylinder head, whereby the turning of the clamp member around a clamp bolt is prevented.

In recent years, a DOHC 4-valve type engine provided with two suction-exhaust valves per cylinder for the purpose of improving a suction-exhaust efficiency of the engine and rotating the engine at a higher speed is becoming a main stream engine. Regarding a direct injection type DOHC 4-valve diesel engine in which an injector is positioned between two cam shafts, there is a known injector fixing structure in which an injector is provided in the center of a space surrounded by cams for operating a suction valve and an exhaust valve.

There is a known fuel injection system shown in Fig. 7. This fuel injection system is provided with an injection pump 42 adapted to suck up a fuel from a fuel tank 41 and pressurize the same, a pressure accumulating pipe 43 forming a common rail for storing therein a high-pressure fuel discharged from the injection pump 42, oil feed pipes 45 communicating the injection pump 42 and pressure accumulating pipe 43 with each other, injectors 44 fixed to the cylinders in a multicylinder engine, fuel injection pipes 48 communicating the pressure accumulating pipe 43 and injectors 44 with each other, an oil return pipe 46 for returning the high-pressure fuel from the oil feed pipes 45 to the fuel tank 41 when the inner pressure of the pressure accumulating pipe 43 becomes not lower than a predetermined level, and a check valve 47 provided at an intermediate portion of the oil retum pipe 46. The pressure accumulating pipe 43 forms a common rail for supplying a high-pressure fuel to the injectors 44. The pressure accumulating pipe 43 is connected to the injection pipe 42 and injectors 44 via connectors 50, 49. Namely, the pressure accumulating pipe 43 is connected to the fuel injection pipes 48 via the connectors 49, and to the oil feed pipes 45 via the connectors 50. In such a system, electromagnetically operated injectors produced by modularizing injecter driving electromagnetic actuators are utilized in many cases.

In the direct injection type DOHC 4-valve diesel engine described above, the fixing of injectors to a cylinder head by clamps poses the following technical problems.

(1) It is difficult to form stepped clamping pressure receiving surfaces on the portions of an injector at lower position than a path of a turning movement of a cam. In the injector fixing structure, the arrangement of a cam and a cam shaft is already designed to such a degree of strictness that causes the reduction of the dimensions of the structure to nearly reach the limit thereof. Therefore, in order to provide a pair of stepped clamping pressure receiving surfaces, against which bifurcated injector pressing portion is pressed, on a cylinder head, it is necessary that the portions of the cylinder head which are far away from a cam and a cam shaft be selected so that the clamping pressure receiving surfaces do not interfere with the rotating cam. Accordingly, the clamp for an injector cannot be provided on the lower portion of a cylinder head which is close to a cam shaft, so that it becomes difficult to reduce the height of the injector.

(2) In order to use a modularized injecter, an injector of a little larger size which has an enough capability is necessarily selected since injectors the sizes of which meet the requirements for an every type of engine are not available. Consequently, the diameter of the injector becomes larger, and the clamping

pressure receiving surfaces have to be provided on the portions of a cylinder head which are far away from a cam and a cam shaft in the same manner as in the case of (1) above so that these surfaces do not interfere with the rotating cam. It is difficult to provide a clamp for an injector on a lower portion of a cylinder head, in other words, it is difficult to reduce the height of the injector.

(3) A modularized injector as a whole is held in a case. When the clamping pressure receiving surfaces of an injector against which an injector pressing member, such as a bifurcated portion of a clamp member is pressed are formed on the case, the case is deformed due to a load imparted thereto, and a fuel injection control unit provided in the case would be damaged. Increasing the wall thickness of the case so as to improve the strength thereof is conceivable but this makes it necessary to provide a larger space for the installation of an injector, so that the mountability of the injector on a cylinder head lowers.

(4) When a nozzle holder portion of an injector is extended in the upward direction in which a strict limitation is not placed regarding the interference of a pair of clamping pressure receiving surfaces of the injector with a cam and a cam shaft with the clamping pressure receiving surfaces, against which an injector pressing portion, such as a bifurcated portion of a clamp member is pressed, provided on such an extended portion, the height of the injector increases, and the interference of the clamping pressure receiving surfaces with other parts around the engine becomes liable to occur.

When the above-described conventional clamp member, on which a means for preventing the turning of the clamp member around the clamp bolt is provided, is tightened onto a cylinder head by the bolt, there is the possibility that the position of a pin type projection changes in accordance with the flexure of the clamp body. Moreover, the function of preventing the injector from being turned around the axis thereof is not sufficient, and an accurate turn-stopping means for the clamp member cannot be obtained. A sealing load is not uniformly imparted to the gas sealing nozzle packing for the injector, and the imperfect sealing of the portion between a combustion chamber and an injector fixing bore cannot be improved.

An aim of the present invention is to provide an injector fixing structure for engines, by efficiently utilizing a space in which cams and cam shafts are provided, with attention being given to the possibility that a fuel supply boss and a fuel return boss on the injector be provided between two cams on a suction-exhaust valve driving cam shaft; forming the injector pressing surfaces of a clamp member on the upper side of the two bosses so as to lower the portion to be clamped of the injector; and fixing the injector compactly at a lower portion thereof to a cylinder head so as to reduce the height of the injector.

Another aim of the present invention is to provide an injector fixing structure for engines, by lowering the portion to be clamped of the injector, making a space around an upper portion of the injector sufficiently large, and providing a driving unit comprising an electromagnetic driving unit in an upper portion of the injector.

Still another aim of the present invention is to provide an injector fixing structure for engines, by providing a turn-stopping member on an injector instead of on a clamp member so as to fix the positions in which the injector is pressed by the clamp member, whereby not only the displacement of the turn-stopping member during a clamp member tightening operation and the turning of the clamp member around a clamp bolt which is ascribed to the vibration caused by the operation of the engine but also the turning of the injector around its axis is prevented.

The present invention relates to an injector fixing structure for engines, having cam shafts parallel-arranged above a cylinder head, suction-exhaust valve operating cams mounted on the cam shafts, injectors provided with fuel supply bosses and fuel return bosses, and clamp members fixed to the cylinder head, the injectors being fixed to the cylinder head by the clamp members, characterized in that the injectors are provided between the cam shafts and between the cams, the fuel supply bosses and fuel return bosses being provided with clamping pressure receiving surfaces, these clamping pressure receiving surfaces being positioned above the cam shafts and between the cams, the clamp members being brought into contact with the clamping pressure receiving surfaces and thereby fixed to the cylinder head, whereby the injectors are fixed to the cylinder head.

In this injector fixing structure, at least one of the fuel supply boss and fuel return boss is preferably provided with a locking portion adapted to be engaged with the clamp member and prevent the turning of the same.

Each injector is preferably provided in an upper portion thereof with an electromagnetic injector actuator, and the fuel supply boss and fuel return boss are formed below this actuator.

Since this injector fixing structure is constructed as described above, the fuel supply boss and fuel return boss can be provided close to the cam shaft without interfering with the rotation of the two cams on the cam shaft. When the clamp member is pressed against the clamping pressure receiving surfaces formed on the two bosses, by tightening the clamp member onto the cylinder head via, for example, a clamp bolt or a nut, the injector is fixed to the cylinder. During this time, the injector, on which the fuel supply boss and fuel return boss having fuel flow passages therein are formed in an outwardly projecting state, is fixed compactly and efficiently and in a low position with respect to the cylinder in a narrow space in the cylinder in which the cams and cam

shaft are provided.

Since a locking portion adapted to be engaged with the clamp member and prevent the turning of the clamp member and injector is formed on at least one of the fuel supply boss and fuel return boss, the displacement of the locking portion during a clamp member tightening operation is avoided. Since the locking portion contacts the clamp member, the turning of the clamp member around the clamp bolt is prevented even when vibration occurs due to the operation of the engine, and also the turning of the injector around its axis is prevented.

When the injector is of the electromagnetic actuator-carrying type, the portion to be clamped of the injector can be lowered by forming the fuel supply boss and fuel return boss below the actuator. In such a case, the electromagnetic actuator is provided in an upper space of a sufficient volume in the injector, so that the height of the injector fixing structure can be reduced.

Since this injector fixing structure is constructed as described above, the two bosses can be provided as close as possible to the cam shaft. Consequently, even a modularized injector does not require a pressure receiving portion, against which the clamp member is pressed, on the case. Moreover, the injector can be pressed in a low position with respect to the cylinder head, and the height at which the injector is fixed to the cylinder head can be minimized.

The clamping pressure receiving surfaces can be formed wider with ease than those with which a conventional clamp member is engaged, by removing the upper portions of a required thickness of the fuel supply boss and fuel return boss. Therefore, the pressure which the clamping pressure receiving surfaces are to receive can be lowered. Consequently, the material out of which these two bosses are formed can be designed easily with respect to the strength of the products, and the manufacturing cost can be reduced. The same applies to the clamp member provided with injector pressing surfaces.

In a conventional operation for setting a clamp member on an injector, the clamping pressure receiving surfaces are formed by cutting off the side portions of an upper part of the injector, so that the fixing of the clamp member to the injector is necessarily done in the lateral direction. According to the present invention, the distance between the two clamping pressure receiving surfaces formed on the upper portions of the fuel supply boss and fuel return boss can be set larger than the diameter of an upper portion of the injector. Consequently, the fixing of the clamp member to the injector can be done along the axis of the injector, i.e., from the upper side thereof, so that the operation efficiency during the assembling of the injector fixing structure becomes very high.

This injector fixing structure is preferably provided with a locking portion, which is adapted to be engaged with the clamp member and prevent the turning of the injector, on at least one of the fuel supply boss and fuel return boss. Therefore, even when the clamp member is slightly deformed during a clamp member tightening operation, the position of the turning stopping portion does not substantially vary, and the turning stopping function thereof is not spoiled. Accordingly, even when the injector is likely to be turned around its axis is applied due to the vibration occurring in accordance with an operation of the engine, the turning stopping portion restricts the behavior of the injector reliably, and the sealing performance of the nozzle packing provided between the combustion chamber and injector fixing bore can be secured.

When this injector fixing structure of the type which has an electromagnetic injector actuator in an upper portion of the injector, the fuel supply boss and fuel return boss are formed below the injector actuator. This enables the injector as a whole to be formed compactly, and the height of the injector to be reduced to a low level.

A preferred embodiment of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

Fig. 1 is a sectional view showing an embodiment of the injector fixing structure for engines according to the present invention;
Fig. 2 is a side view of the injector fixing structure of Fig. 1;
Fig. 3 is an enlarged sectional view showing a principal portion of the injector fixing structure of Fig. 1 in a clamped state;
Fig. 4 is an enlarged plan showing a principal portion of the structure in a clamped state of Fig. 3;
Fig. 5 is a plan view of a clamp member used for the injector fixing structure of Fig. 1;
Fig. 6 is a sectional view of the clamp member of Fig. 5;
Fig. 7 is a piping system diagram in a conventional injector fixing structure for multicylinder engines;
Fig. 8 is a sectional view showing an example of a conventional injector fixing structure adapted to fix one injector separately to a cylinder head; and
Fig. 9 is a sectional view taken along the line A-A in Fig. 8.

An embodiment of the injector fixing structure for engines according to the present invention will now be described. In the accompanying drawings, the parts the construction and function of which are identical with those of the parts of a conventional injector fixing structure are designated by the same reference numerals.

As shown in Fig. 1, the injecter fixing structure in this embodiment is applied to a multicylinder engine. In this injector fixing structure, a plurality of injectors are arranged in series as shown in Fig. 2. Each injector 1 is of an electromagnetically operated type having an electromagnetic actuator 4 in an upper portion thereof, and a fuel supply control unit controls the operation of the

electromagnetic actuator 4, whereby the timing and a rate of injection of a fuel from the injector 1 into a combustion chamber are controlled. The injector 1 is press fitted in a fixing bore 3 formed in a cylinder head 2, and it is fixed to the cylinder head 2 by a clamp member 25 so as to press a nozzle packing 24 and seal a boundary portion between the combustion chamber and fixing bore 3.

A cam carrier 6 is fixed to an upper portion of the cylinder head 2, and two parallel-extending cam shafts 8, 9 are held between the cam carrier 6 and a cam bracket 7. The cam shafts 8, 9 are rotated as a predetermined rotational phase relation is maintained with respect to each other. The cam shaft 8 is mounted at the portions thereof which are on both sides of one injector 1 with two cams 10, 11. The cam shaft 9 is also mounted at the portions thereof which are on both sides of one injector 1 with two cams 12, 13. Accordingly, four suction-exhaust valves operated by these cams correspond to one injector 1.

The circles 14, 15 shown by broken lines represent the paths of free ends of the cams 10, 11; 12, 13 turned by the cam shafts 8, 9. The cam 10 mounted on the cam shaft 8 and the cam 12 mounted on the cam shaft 9, and the cam 11 mounted on the cam shaft 8 and the cam 13 mounted on the cam shaft 9 are disposed so as to be opposed to each other in a plane crossing the axes of the cams. Since the operating timing of the suction-exhaust valves for the cams 10, 11; 12, 13 is different, the phases of the cams are different. Therefore, the cams 10, 11; 12, 13 do not interfere with each other during the rotation of the cam shafts 7, 8, though the paths 14, 15 of the free ends of the cams overlap one another in the drawing.

The injector 1 for a direct injection type engine is disposed in the center of a space surrounded by the four cams 10, 11, 12, 13 for driving suction valves and exhaust valves. An injector body 22 is provided with a fuel supply boss 16 in which a fuel supply passage 18 for supplying a fuel to a lower end 23 of a nozzle is formed, and a fuel return boss 17 in which a fuel return passage 19 for returning a leakage fuel to a tank is formed, in such a manner that these bosses 16, 17 are formed at opposite position with each other unitarily with the injector body 22 and extend diagonally upward so as to cross the cam shafts 8, 9. The fuel supply boss 16 is provided above the cam shaft 8 and between the cams 10, 11, while the fuel return boss 17 is provided above the cam shaft 9 and between the cams 12, 13, these positions in which the bosses 16, 17 are provided being set as close as possible to the cam shafts 8, 9 so as to minimize a clearance between the cam shafts 8, 9. Accordingly, the positions in which the fuel supply boss 16 and fuel return boss 17 are provided are set low and as close as possible to the cylinder head.

The portions of an upper surface of the injector body 22, on which the fuel supply boss 16 and fuel return boss 17 are provided, which are closest to the cam shafts 8, 9 are provided with clamping pressure receiving surface portions 20, 21 with which the clamp member 25 is engaged. The clamping pressure receiving surface portions 20, 21 are formed flat by cutting off the upper portions of a required thickness of the bosses 16, 17. The clamping pressure receiving surface portions 20, 21 can be provided comparatively widely on the upper portions of the bosses 16, 17, and reduce the surface pressure received from injector pressing surfaces 28, 32. Since a distance between the clamping pressure receiving surface portions 20, 21 is set larger than the diameter of any part of an upper portion of the injector, a bifurcated portion 27 of the clamp member 25 can be set on the relative injector 1 from the upper side thereof.

The clamp member 25 for fixing a series of three injectors 1 arranged in series to the cylinder head 2 is formed out of an elastic metal material, and the shape in plan of this clamp member 25 as a whole is like that of an elongated plate. As shown in Fig. 5, the clamp member 25 is provided at both end parts 26 thereof with bifurcated portions 27 for holding both of the outer side injectors 1, and at an intermediate part 29 thereof with a hole 30 through which an intermediate injector 1 is inserted. The clamp member 25 is further provided at the parts thereof which are halfway between both end parts 26 and the intermediate part 29 with bolt insert holes 33 through which clamp bolts 34 are inserted. The clamp member 25 is fixed to the cylinder head 2 by the clamp bolts 34.

When the clamp member 25 is pressed against the cylinder head 2 by inserting the clamp bolts 34 into the bolt insert holes 33 and screwed to the cylinder head 2, the injector pressing surfaces 28 formed on lower parts of the free end regions of the bifurcated portions 27 press the clamping pressure receiving surface portions 20, 21 formed on the fuel supply bosses 16 and fuel return bosses 17 of both side injectors 1, whereby both side injectors 1 are fixed in the fixing bores 3. The injector pressing surfaces 32 formed on lower portions of both side parts 31 of the intermediate hole 30 press the clamping pressure receiving surface portions 20, 21 formed on the fuel supply boss 16 and fuel return boss 17 of the intermediate injector 1, whereby the intermediate injector 1 is fixed in the relative fixing bore 3.

As is clear from a cross-sectional view of the clamp member 25, the portions thereof which are provided with bolt insert holes 33 are formed as thicker portions to improve the rigidity thereof, while the bifurcated portions 27 having injector pressing surfaces 28, and both side parts 31 of the intermediate hole 30 which have injector pressing surfaces 32 are formed thinner and bent so as to be recessed arcuately at the side of the cylinder head 2, whereby the elasticity of the portions 27 and parts 31 is improved. The lower portions of the circumferential parts of the bolt insert holes 33 are recessed arcuately so as to lessen the stress concentration occurring in the lower end opened portions during a clamp member tightening operation. Regarding the detailed construc-

tion of the clamp bolt 34 with respect to the bolt insert hole, the form of a spherical washer can be applied to a head portion of the bolt and the bearing surface of a nut.

The height of the clamping pressure receiving surface portions 20, 21 of the three linearly arranged injectors 1 is set to an equal level. In the clamp member 25, the injector pressing surfaces 32 for the intermediate injector 1 are set higher by a difference

than a straight line connecting the injector pressing surfaces 28 for the both-side injectors 1 together. Accordingly, the elastic modulus attained by the intermediate injector pressing surfaces 32 after the clamp member 25 has been tightened by clamp bolts 34 to cause the intermediate injector pressing surfaces 32 to be engaged with the clamping pressure receiving surface portions 20, 21 is higher than that attained by the injector pressing surfaces 28 on both sides. After all, as is clear from a curve showing the relation between the level of a force causing the tightening force of the injector pressing surfaces 32, 28 for the three injectors to be produced and the displacement of the clamp member, it becomes easy to give a flexibility to the clamp member so that the level of the tightening force at the three portions thereof becomes equal.

The details of the engagement relation between the injector pressing surfaces 28, 32 and the clamping pressure receiving surface portions 20, 21 are shown in Figs. 4 and 5. The inner side surfaces 37 of the bifurcated portions 27 or both side portions 31 of the intermediate hole 30 are engaged with or opposed with narrow clearances left to the side surfaces 36 of the case 35 covering an outer side of the injector 1. On the side of the fuel supply boss 16, an outer surface 28 of a blade of the bifurcated portion 27 or the side portion 31 of the intermediate hole 30 is engaged with or opposed with a narrow clearance left to a contact surface 40 of a turning stopping portion 39 formed unitarily with the fuel supply boss 16 so as to project upward.

Therefore, even when an elastically deforming force is imparted to the clamp member 25 when the injecter 1 is fixed to the cylinder head 2 by tightening the clamp member 25, an influence of the force upon the positional relation between the outer side surfaces 38 of the bifurcated portions 27 or the side portions 31 of the intermediate hole 30 and the contact surface 40 of the turning stopping portion 39 formed on the fuel supply boss 16 is small, so that the tightening force applied to the injector 1 does not become uneven. This enables the sealing by the nozzle packing 24 to be done reliably. Even when the vibration resulting from the operation of the engine causes a force for turning the injector 1 around the axis thereof to be imparted to the injector 1, the injector 1 turns directly or after it has offset the narrow clearance, and the contact surface 40 of the turning stopping portion 39 provided on the injector 1 is thereafter restricted by the relative blade of the bifurcated portion 27 or the outer side surface 38 of the relative side portion 31 of the intermediate hole 30, so that the further turning of the injector 1 is prevented.

In this embodiment, an injector fixing structure for multicylinder engines which is provided with electromagnetically operated injectors having electromagnetic actuators in the upper portions thereof. This injector fixing structure can also be applied to a diesel engine having a general injection system and a cylinder injection type gasoline engine as long as the engines have injectors arranged thereon.

Claims

1. An injector fixing structure for engines, having cam shafts (8, 9) arranged in parallel above a cylinder head (2), suction-exhaust valve operating cams (10, 11, 12, 13) mounted on said cam shafts, injectors (1) provided with fuel supply bosses (16) and fuel return bosses (19), and clamp members (25) fixed to said cylinder head, said injectors being fixed to said cylinder head by said clamp members,

   characterized in that said injectors are provided between said cam shafts and between said cams, said fuel supply bosses and said fuel return bosses being provided with clamping pressure receiving surface portions (20, 21), said clamping pressure receiving surface portions being disposed above said cam shafts and between said cams, said clamp members being brought into contact with said clamping pressure receiving surface portions and thereby fixed to said cylinder head, whereby said injectors are fixed to said cylinder head.

2. An injector fixing structure for engines according to Claim 1, wherein at least said fuel supply bosses or said fuel return bosses are provided with locking portions (39, 40) adapted to be engaged with said clamp members and prevent the turning thereof.

3. An injector fixing structure for engines according to Claim 1 or 2, wherein said injectors are provided in the upper portions thereof with electromagnetic injector actuators (4), said fuel supply bosses and said fuel return bosses being provided below said electromagnetic injector actuators.

FIG. 1

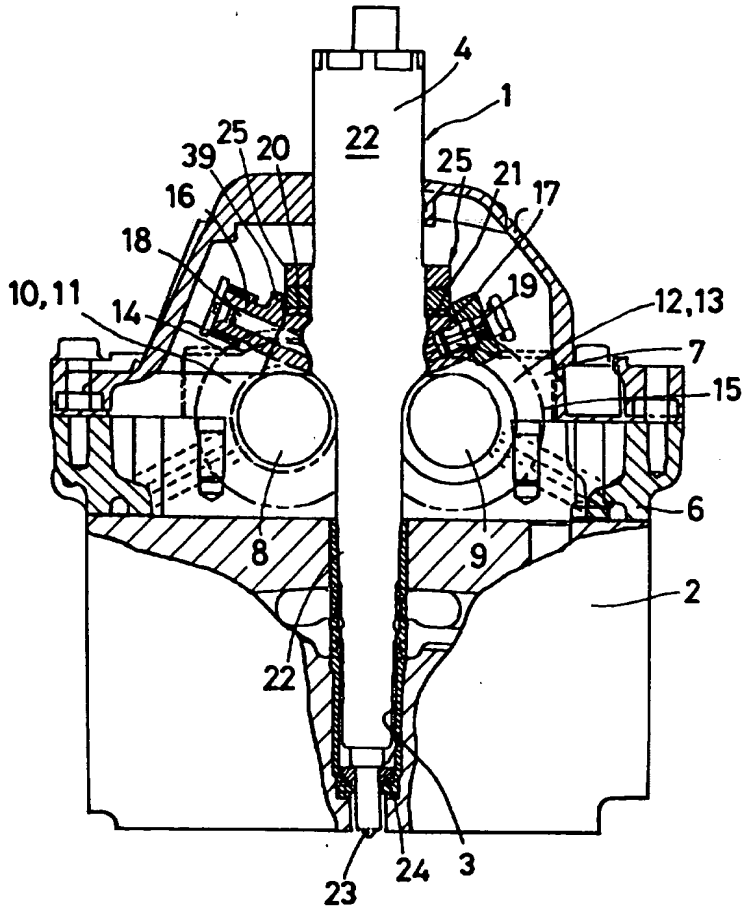

FIG. 2

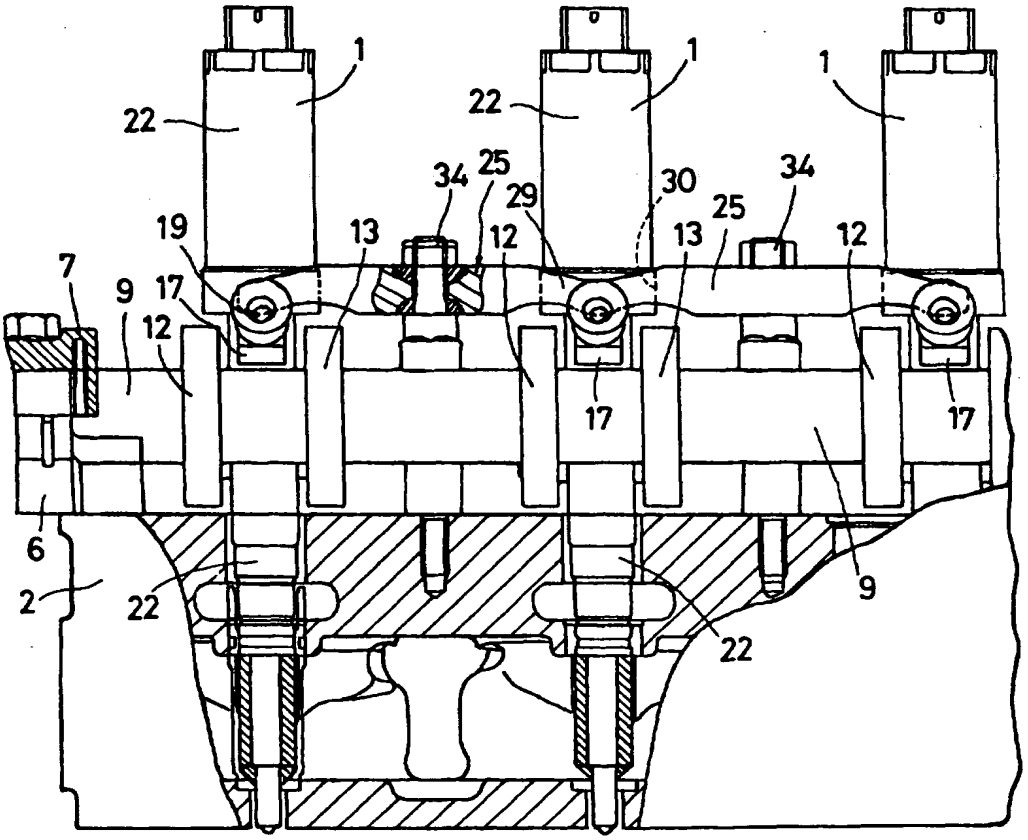

FIG. 3

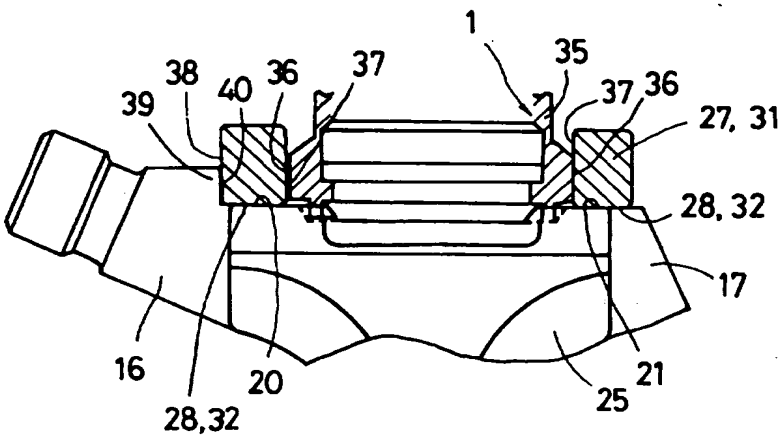
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FIG. 4

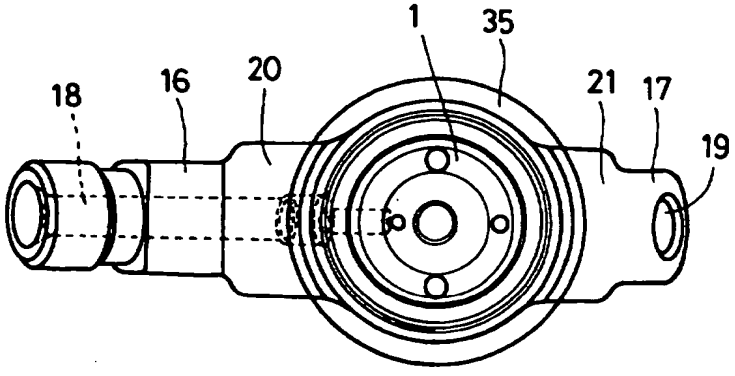
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FIG. 5

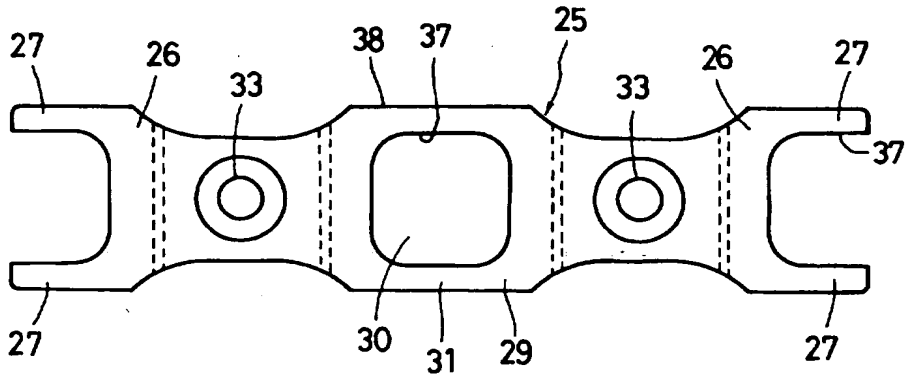
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FIG. 6

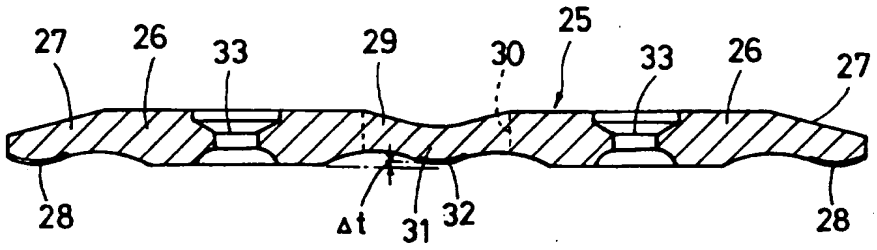
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FIG. 7 (PRIOR ART)

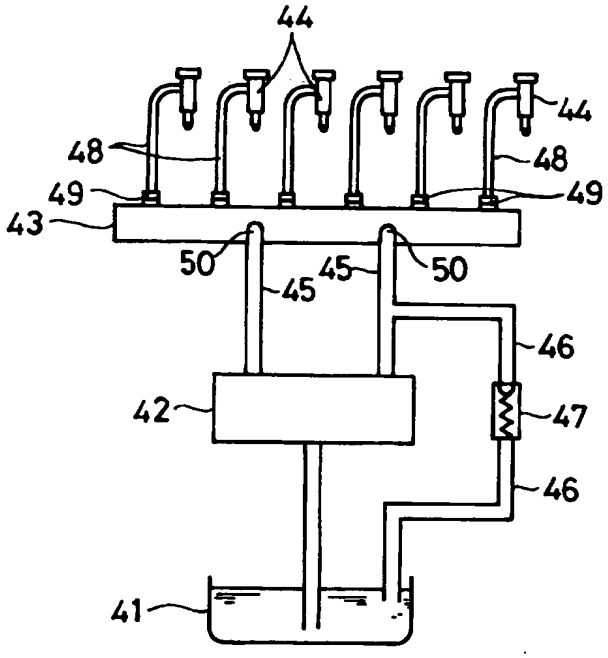


FIG. 8 (PRIOR ART)

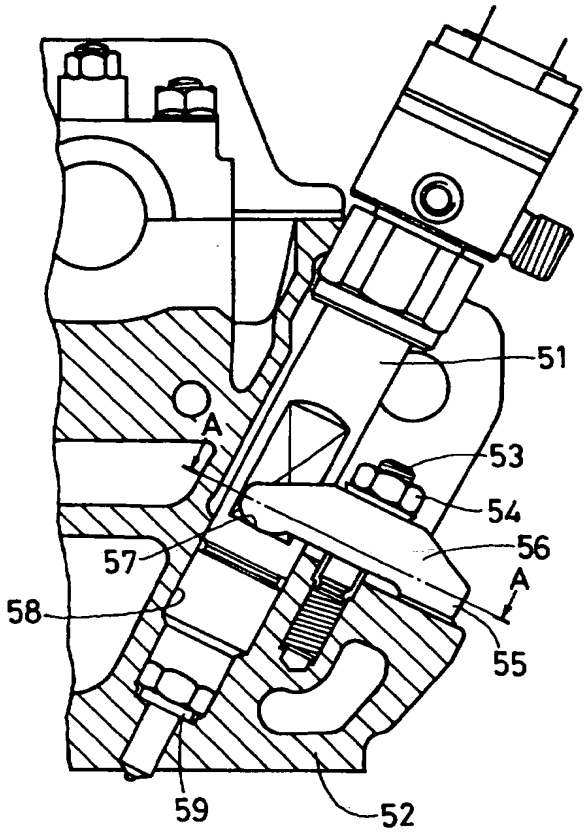
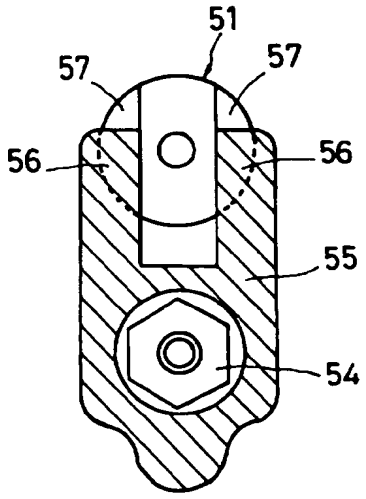


FIG. 9 (PRIOR ART)



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 8331

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE 42 05 263 A (KLOECKNER HUMBOLDT DEUTZ AG) 26 August 1993 * column 2, line 64 - column 3, line 33; figures 1-3 *	1,2	F02M61/14
A	DE 43 15 233 A (DAIMLER BENZ AG) 28 July 1994 * column 2, line 31 - column 3, line 20; figures 1-3 *	1	
A	US 3 325 104 A (V.D. ROOSA) 13 June 1967 * column 2, line 35 - column 3, line 50; figures 1-3 *	1	
P,A	EP 0 724 075 A (TOYOTA MOTOR CO LTD) 31 July 1996 * column 3, line 36 - column 5, line 45; figures 1,2 *	1	
E	EP 0 751 290 A (ISUZU MOTORS LTD) 2 January 1997 * column 5, line 3 - column 6, line 9; figures 3-6 *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.6) F02M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	27 February 1997	Hakhverdi, M

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